1,008,503

PATENT SPECIFICATION

DRAWINGS ATTACHED

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1,008,503

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Int. Cl.: —B 24 b//C 23 g, F 06 k

COMPLETE SPECIFICATION

Process and Apparatus for the Surface Treatment of Articles

We, AJEM LABORATORIES, INC., a Corporation organised and existing under the laws of the State of Michigan, United States of America, of 38899 Schoolcraft Road, Livonia, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a process and apparatus for surface treating an article such as for power washing or surface reforming, for example, deburring, abrading or peening. More particularly, the invention relates to apparatus for intermittently producing high velocity liquid jets for surface reforming articles, without the "water-hammer" and other disadvantageous effects of sudden stoppage and difficulties of rapid build-up of the required high velocity.

Such problems are presented especially in the surface treatment of manufactured metal parts, for example, for cleaning, removal of scale or deburring, and in some cases, for alteration of the surface microcrystalline structure by methods such as shot peening. All such treatments will be referred to generally in this specification and claims as "surface-reforming". There have heretofore been known in this art power washers, using sprays and jets in various ways for loosening and washing away soil of various kinds. These have included mechanical devices for moving the parts being treated into various orientations to the jets, and for moving jets into suitable orientations, even for washing jet carrying mandrels into small openings.

The present invention consists in a process utilising one or more jets of liquid for surface treating an article, in which the or each jet is repeatedly initiated by a stream of liquid which has substantially maintained high velocity and is repeatedly diverted from and returned to the or each jet to produce a pulsed jet, whereby surface treatment is made more effective by drainage of the liquid during the period of interruption of the or each jet.

Thus, with the present invention, intermittant jets strike with sudden high velocity and then allow the liquid to drain away and strike again with the high velocity jet when enough of the liquid has drained back along the surface so that the jet can be fully effective once more and repeating as often as required. The result of this is to make a given amount of water or other treating liquid do more useful work and likewise to increase efficiency of use of energy imparted to the liquid in the high velocity stream.

In the complete specification of our copending application No. 30841/60 (Serial No. 965,551) a new method of surface reforming by blasting with solid particles suspended in a suitable liquid is described and claimed. A clear liquid, such as water, is forced at high velocity from orifices to form jets of a suspension of solid particles for the surface reforming operation. These particles may be various grits, for example, for abrasive scouring or deburring, or in the case of peening, steel shot and the like. The jets pick up and accelerate surface reforming particles by ejector action; and, when an article or object to be treated is placed in the path of the jets, very effective surface reforming results.

These processes have revolutionized the surface treatment of many parts, particularly metal castings in the automotive industry. The outer surfaces of such castings can readily be treated by the process and apparatus disclosed in the aforementioned application, but difficult problems are encountered with parts having scale or adhering flakes

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etc., to be removed or small cavities, for example tapped holes to be smoothed, deburred, cleansed of oils, chips, abrasives, etc. Once such surface is covered with the liquid, and especially when small holes are filled with the liquid, the surfaces are insulated thereby from the intended action of the jets, and then there is no longer any strong blast of suspended solids actually striking the surfaces to be treated.

The present invention facilitates cleaning out small cavities by reason of the intermittent jets or blasts of liquid, with or without suspended grit, which strike the cavity opening at a suitable angle. The invention has an additional unexpected advantage that it improves the overall surface reforming effect even on level surfaces. This is a very advantageous and rather uncommon phenomenon. Usually when a special problem is solved by a modified process there has to be some compromise, and it is rare that the overall operation of the general process is actually improved.

Thus, the present invention also consists in apparatus for surface reforming an article comprising a container for a liquid suspension of surface reforming particles, at least one jet orifice for producing a liquid jet in the container for entraining surface reforming particles, a blast tube substantially aligned with the jet and extending from adjacent the jet orifice towards the article to be surface reformed, means for supplying to said jet orifice liquid under such a pressure as to produce a jet of sufficient velocity to accelerate the surface reforming particles to velocities effective for surface reforming, and means for periodically diverting the liquid under pressure from the orifice and then suddenly re-establishing the jet flow, whereby a pulsed jet is produced.

In operations using the present invention, the jet of cleaning solution or surface reforming liquid is frequently interrupted and the surfaces are repeatedly subjected to bursts, or sudden blasts, of the treating liquid. If the jets are pulsed, for example operating on and off for only a fraction of a minute, even as briefly as a second each, the suspension drains back from its condition of dynamic balance during the jet flow so that, even in the small cavities from which the liquid cannot fully drain out, it no longer prevents the next pulse of the jet from producing an effective scouring etc. of the inner surfaces of cavities, and the other surfaces over which the liquid drains. Advantageously, the part is held or turned so that liquid will drain out from such cavities while the jet is interrupted. As a result, thorough surface reforming of the surfaces is effected in one machine and without need for hand labor.

Surprisingly, even on large surfaces which do not present the problem of small cavities the effectiveness of the blasting operation is actually improved by such intermittent bursts and interruptions. Apparently the sudden onset, as a jet starts, improves the cleaning and removal of surface scale and the like, probably because sudden impact stresses before any reaction effects have occurred to obstruct or counter balance them.

In any event the removal of the undesirable material is actually improved by pulsing the jets, and the present invention is not limited to any theory of why this is so.

The jet pulsation and interruption can be effected, to some extent, by a simple on and off valve, but it is much better to divert a continuously flowing high velocity stream successively to different jet orifices. In this way a constant load on the pump is maintained and the inertia of the flowing stream is utilized to get sudden bursts of the liquid, rather than gradual acceleration at each set of orifices, thus attaining much greater effectiveness than if the flow were actually stopped altogether. Where there is a plurality of jet orifices, the high pressure water may be periodically and succesively diverted to the several orifices in turn; but, where that is not feasible, the flow can be diverted back to a reservoir in order to avoid interruption of flow in the high pressure stream. The shift from one path to another should be as rapid as possible so as to provide a sudden burst of liquid from the jet to which the flow is diverted. In the specific description, to follow, two types of valves embodying this invention are illustrated. It should be understood that these are typical, and representative of others which can be used.

In order that the present invention may be more readily understood, reference will now be made to the accompanying drawing in which the invention is illustrated as applied to apparatus of the kind described and claimed in the aforementioned application and in which:—

Fig. 1 is a section, in semi-diagrammatic form, of a piston type valve connected to two blasting jets shown diagrammatically;

Fig. 2 is an end view of a different type of valve, and

Fig. 3 is a side view of the valve of Fig. 2.

In Fig. 1 the bottom portions of two tanks or containers for liquid suspensions of surface reforming particles are shown diagrammatically in section. The tanks 1, 1^1 are illustrated as formed with conical settling chambers in which are jet orifices or nozzles 2, 2^1 and coaxial blast tubes 3, 3^1. The water is supplied under relatively high pressure through orifices 2, 2^1 from the conduits 4, 4^1.

In operation a jet of water through each of the orifices 2, 2^1 in turn, entrains some of a slurry of surface reforming particles which settle in the bottoms of tanks 1, 1^1 around the gaps between the orifices 2, 2^1

and blast tubes 3, 3¹. This slurry, entrained with the high velocity liquid jets, is then accelerated in the blast tubes 3, 3¹ so that it strikes with high velocity on articles 6, 6¹ which are positioned or moved into the blasts from tubes 3, 3¹. The positioning and movement of such articles is now known, and examples are disclosed in prior patent specifications, for example, the aforementioned application and United States Patent Nos. 2832461, 2900991, 2918071, 2925614, 2926674 and 2926675.

The clear liquid supply conduits 4, 4¹ communicate with a valve chamber 9 in which a slide valve 10 moves periodically. High pressure water inlet 11 is at a central position in valve 9.

In the position illustrated in Fig. 1 with the piston at the left, the conduit 4 is closed and conduit 4¹ provides open passage for the high pressure liquid from 11. Hence a high velocity jet will flow from the orifice 2¹ and a blast from 3¹ will be established in the right-hand tank 1¹. Periodically, for example every other second, the piston valve rapidly moves to the position shown in dashed lines, diverting flow from the right-hand tank to and through the orifice 2 of the left-hand tank. The sequence is repeated continually; and articles 6, 6¹ which are positioned in the blast are thus treated, first being struck by the blast and then allowed to drain, and then, when the surface is once more freed of liquid, again being subjected to the blast. Because the flow of liquid is successively and alternately directed to the orifices 2 and 2¹, without stopping the flow of liquid, the blast is of greatest possible velocity and impact force at all times, the deterioration of apparatus by "water hammer" and other inertial effects is substantially avoided.

It will be noted that the intermittent or pulsed jet formation is effected in the clear liquid supply, but the liquid may nevertheless carry some fine abrasive particles. The diversion is controlled by operation of the motor 12, which is sealed from the liquid by a gland 8. The fluid pressure motor 12 and the means for supplying fluid pressure and suction alternately to its connections 13 and 14 may be of types already known in the art.

Because the tanks 1, 1¹ are shown in transverse vertical section, it appears as if each tank had only a single jet orifice. This may often be so, but in many cases a plurality of orifices and blast tubes or a slot orifice and elongated blast tube, for example, as set forth in our copending application No. 30841/60 965551, may be used, so that a ribbon-like jet is produced, which is advantageous in the treatment of some articles. Where there are multiple orifices, it is by no means necessary that the diverted flow go to a different machine or a different tank. On the contrary, it is often more advantageous to divert the flow from one orifice to another in the same blast tank.

For some operations it is desirable to have multiple sets of orifices in each blast tank. These orifices and blast tubes advantageously are at different angles each best suited to treating a particular part of the article to which it is directed. The present invention is well suited to the pulsing of such multiple jet sets.

Another type of interrupting valve, which acts also as a distributor, is shown in Figs. 2 and 3. Here a valve body 9*a* is provided with a plurality of outlets 4*a* in its face. Within the body 9*a* is a rotatable distributor 10*a* having a slot 15. The axial inlet, or liquid feed pipe 11*a* communicates with the hollow passage of the slot and the passage extends outward so as to communicate also with the outlets 4*a*. As the shaft 17 turns the distributor 10*a*, the slot 15 successively communicates with one outlet 4*a* after another, as is best seen in Figure 2, and therefore in a single revolution the high pressure liquid will successively have been directed to each of four outlet tubes in turn. Because the slot 15 communicates with each outlet 4*a* before it is cut off from the previous one, the high velocity flow of liquid is never shut off, and the inertia of the liquid is used to rapidly build up the velocity in each jet as a previously connected jet is cut off.

The operation is described in connection with Fig. 1, but the design of the distributor lends itself to installations where there are more than two sets of jet orifices. There are many other types of liquid distributors, which can be used to serve the functions described.

The periodicity of the jet pulses will vary with the nature of the machines used, and nature and orientation of the surface being treated. The pulse rate is determined by the rate at which the valves are driven, and this obviously can be controlled by use of a variable speed electric motor on shaft 17 or by control of the fluid pressure supply to the fluid pressure motor 12, which drives valve 10.

Various types of motors may be used to drive the valve 10. Besides the reciprocating fluid pressure motor indicated diagrammatically at 12 or a simple rotary electric motor mentioned above, we may use a solenoid or a rotary cam or crank device for the slide valve and a rack and pinion with ratchet to convert the action of a reciprocating motor for drive of a slide valve.

WHAT WE CLAIM IS:—

1. A process utilising one or more jets of liquid for surface treating an article, in which the or each jet is repeatedly initiated by a stream of liquid which has substantially maintained high velocity and is repeatedly diverted

from and returned to the or each jet to produce a pulsed jet, whereby surface treatment is made more effective by drainage of the liquid during the period of interruption of the or each jet.

2. A process as claimed in Claim 1, in which the article to be surface treated is subjected to a plurality of jets and the stream of liquid is diverted successively from one to another producing a burst from one of said jets and then from another.

3. A process as claimed in claim 2, in which the jets respectively are directed against the article from different angles.

4. Apparatus for surface reforming an article, comprising a container for a liquid suspension of surface reforming particles, at least one jet orifice for producing a liquid jet in the container for entraining surface reforming particles, a blast tube substantially aligned with the jet and extending from adjacent the jet orifice towards the article to be surface reformed, means for supplying to said jet orifice liquid under such a pressure as to produce a jet of sufficient velocity to accelerate the surface reforming particles to velocities effective for surface reforming, and means for periodically diverting the liquid under pressure from the orifice and then suddenly re-establishing the jet flow, whereby a pulsed jet is produced.

5. Apparatus as claimed in claim 4, in which there are a plurality of jet orifices, and the liquid diverting means is disposed between the liquid supply means and the jet orifices and is adapted successively to pass liquid to and divert it from said orifices, and in which means are provided for actuating the diverting means at a predetermined repetition rate.

6. Apparatus as claimed in claim 5, in which the diverting means is a power actuated piston valve.

7. Apparatus as claimed in claim 5, in which the diverting means is a rotating liquid distributor.

8. A process for surface treating an article, substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing.

9. A process for surface treating an article, substantially as hereinbefore described with reference to Figures 2 and 3 of the accompanying drawing.

10. Apparatus for surface reforming an article, constructed and adapted to operate substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing.

11. Apparatus for surface reforming an article, constructed and adapted to operate substantially as hereinbefore described with reference to Figures 2 and 3 of the accompanying drawing.

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1008503 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

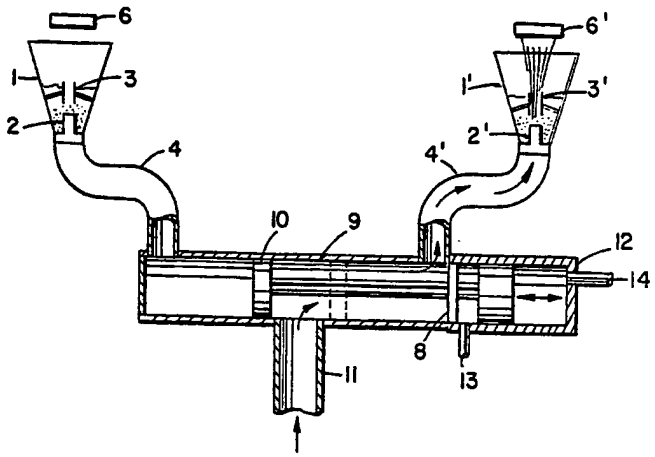

FIG. 1

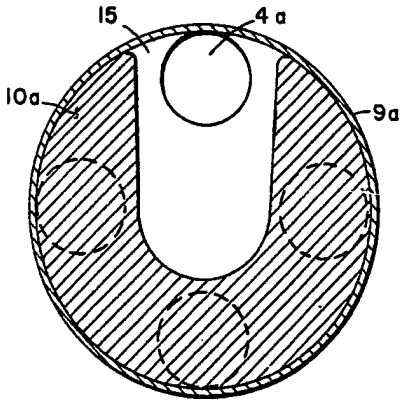

FIG. 2

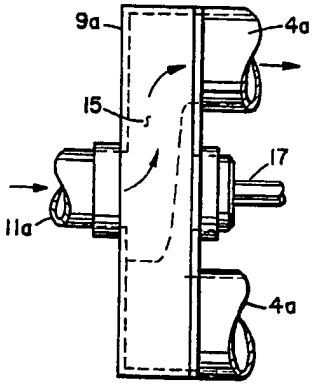

FIG. 3

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PATENTS ACT, 1949

SPECIFICATION NO. 1,008,503

The following amendments were allowed under Section 29 on 14th April 1967

Page 1, line 42, page 3, line 127, *after* "initiated" *insert* "as a high velocity jet"

Page 1, line 43, page 3, line 128, *delete* "has substantially" *insert* "is"

Page 1, lines 43 and 44, page 3, line 129, *delete* "high velocity" *insert* "under pressure"

Page 1, line 47, page 4, line 3, *delete* "drainage of the" *insert* "reason of the drainage away of"

Page 1, line 61, *for* "stream" *read* "jet"

Page 2, line 70, *after* "because" *insert* "of"

Page 2, line 80, page 3, line 95, *for* "velocity" *read* "pressure"

Page 3, line 60, *for* "965551," *read* "Serial No. 965551"

ERRATA

SPECIFICATION NO. 1,008,503

Page 1, Inventors: *for* "Dewey Maire Evans" *read* "Dewey Maine Evans"

Page 1, line 37, *for* "washing" *read* "pushing"

THE PATENT OFFICE
19th June 1967

D 86937/20

carrying mandrels into small openings.

The present invention consists in a process utilising one or more jets of liquid for surface treating an article, in which the or each jet is repeatedly initiated by a stream of liquid which has substantially maintained high

surface treatment of many parts, particularly metal castings in the automotive industry. The outer surfaces of such castings can readily be treated by the process and apparatus disclosed in the aforementioned application, but difficult problems are encountered with parts having scale or adhering flakes

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